PROGRESS REPORT (WC-F-09-02)
Year 1 of 2

TITLE: Testing a new satellite-image analysis technique to monitor pest related-, fire-, and post-fire-mortality in the Northwest Forest Plan area of Oregon

LOCATION: All eastside forestlands within Northwest Forest Plan area in the state of Oregon

DURATION: Year 1 of 2-year project **FUNDING SOURCE:** EM Fire Plan

PROJECT LEADER: Warren Cohen, Pacific Northwest Research Station, USDA Forest Service, Corvallis, OR 97331, wcohen@fs.fed.us. (541) 750-7322

COOPERATORS: Robert Kennedy, Yang Zhiqiang, Oregon State University

FHP Sponsor/contact: Beth Willhite (R6) and Keith Sprengel (R6)

PROJECT OBJECTIVES: 1. Determine the appropriate spatial and temporal grain at which the LandTrendr algorithms can create maps that complement and augment FHM aerial surveys in monitoring severity and trends in pest-related mortality. 2. Utilize derived maps to examine relationships between mortality caused by pest epidemics, post-epidemic community change, wildfire, post-fire management, and post-fire vegetation response to build foundations for future predictive modeling.

JUSTIFICATION:

Significance and priority issues: Tree mortality caused by pest epidemics has long been thought to increase risk of subsequent wildfire, but recent studies have shown the relationships to be far more nuanced and situation-specific than previously assumed. In addition to short and medium-scale climatic conditions, pest agent, forest type and age, time since pest outbreak, and post-outbreak vegetation dynamics likely all contribute to variation in fire dynamics and risk over space and time (Bebi et al. 2003; Kulakowski and Veblen 2007; Kulakowski et al. 2003; Romme et al. 2006; Sibold et al. 2007). If pest epidemics and fire activity in the western U.S. change as expected under climate change scenarios (Hicke et al. 2006; Logan et al. 2003; Westerling et al. 2006), then greater understanding of the interactions between these two disturbance agents will be required to meet two goals of the National Fire Plan: rehabilitation of damaged landscapes and reduction of fire risk to rural communities. The former goal requires long-term monitoring of management effects, while the latter requires effective spatially-explicit modeling of fire risk and fuel loads. Both must be built on an understanding of pre- and post-pest and fire vegetation dynamics.

To meet both goals, spatial and temporally consistent maps of pest mortality, fire severity, and post-fire vegetation dynamics must be mapped across a range of forest type, climatic, and management regimes. While the Forest Health Monitoring (FHM) and the Monitoring Trends in Burn Severity (MTBS) programs produce maps that meet portions of these goals, no spatially and temporal consistent measurement tool exists to capture the full suite of dynamics related to pest, fire, and management. This gap must be filled if spatially-explicit monitoring and modeling of fire and pest dynamics are to be improved.

PROGRESS: Background: Detection of subtle pest effects using Landsat imagery has been shown to be feasible with Landsat TM data (Royle and Lathrop 2002; Skakun et al. 2003; Townsend et al. 2004; Wulder et al. 2006), but it has long been recognized that separation of subtle effects from background noise is difficult when deriving such maps from two dates of imagery alone (Wulder et al. 2005). The trajectory approach utilizes more than 20 years of yearly imagery to markedly increase the signal-to-noise ratio and thereby better separate subtle effects from noise caused by phenological and sun illumination angle across seasons (Kennedy et al. 2007). Under a project backed by the Northwest Forest Plan (NWFP) effectiveness monitoring program, we developed and applied the LandTrendr (Landsat-based detection of trends in disturbance and recovery) algorithms (Kennedy et al. In prep) to forests in the range of the NWFP. From these, the goals of this two-year project are to extract signals likely to be associated with insect and pest disease and mortality, to link those maps with FHM overflight data, and to investigate potential linkages with forest cover and with fire. We are at the completion of Year 1.

OBJECTIVE 1. Compare LandTrendr maps for eastside Oregon forests with FHM pest maps and evaluate best linkages between these datasets using direct field observation. **Methods**: *Image processing and GIS analysis:* We developed new methods to analyze our LandTrendr outputs to produce maps of landscape change dynamics for the study area that includes both the effects of defoliators near Mt. Hood and bark beetles near Cascade Lakes (Figure 1), and have linked these with new cumulative mortality maps derived from aerial survey data by Julie Johnson, Michael Rich, Keith Sprengel, and Beth Willhite. Although field data are still being collected, initial evaluations suggest that the LandTrendr data are capturing a wide range of mortality and defoliation events with high spatial precision, and that they complement the aerial survey data well.

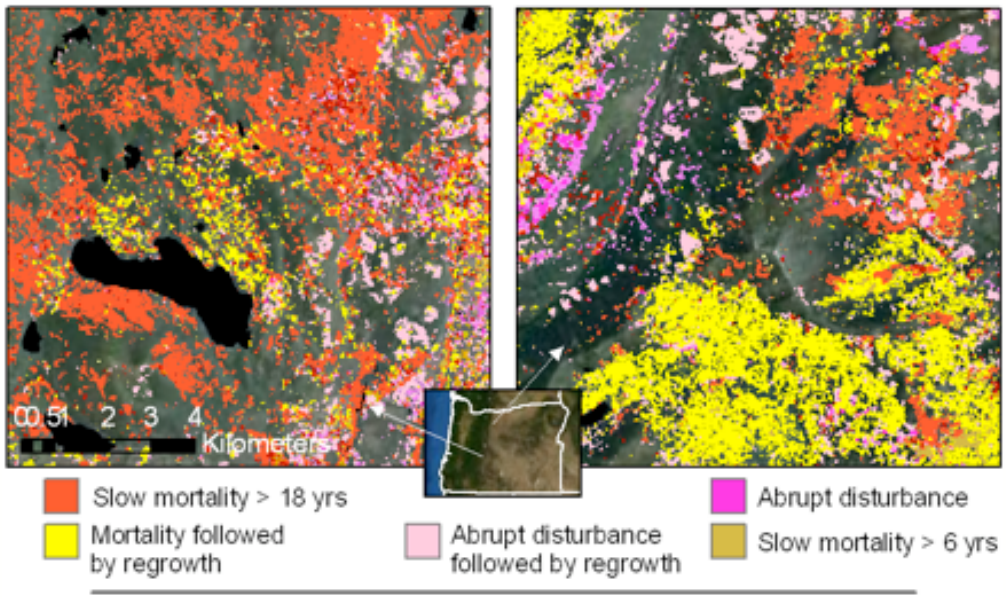

Figure 1. LandTrendr change maps capturing pest-related mortality. a) Cascade Lakes area (Agent: MPB) b) Badger Creek area near Mt. Hood (Agents: SBW and MPB)

Field visits have focused on evaluating areas where both data sets agree on pest effects (either presence or absence) and where the two datasets disagree. Field collections are ongoing through the first part of October, but indicate that our initial LandTrendr maps are accurately capturing effects in the field, including post-mortality forest regrowth (Figure 2).

Figure 2. Pest-related mortality detected using LandTrendr maps. a) Old (1985-1990) and recent (2007-present) lodgepole mortality (MPB), N. side of Lucky Lake, Cascade Lakes area. b) Lodgepole mortality (1985-1995, MPB) plus survival and regeneration, E. side of Newberry Crater. c) Prior fir mortality (1985-1992, WSB) E. of Highway 26 near Twin Lakes, S. of Mt. Hood

OBJECTIVE 2. Objective 2 will begin after the field season draws to a close in October, and will focus on examining linkages between the LandTrendr-based maps of mortality and forest type and fire patterns. Landcover maps will be those developed for the NWFP monitoring program using the GNN approach (Ohmann and Gregory 2002; Ohmann et al. 2007). We will also use daily fire progression maps to examine whether initial location of eventual large fires is related to particular pre-fire dynamics. These relationships will be evaluated for correlative relationships using standard multivariate approaches to uncover potential commonalities in either pre-fire vegetation dynamics or post-fire recovery dynamics.

Products: 1. Landsat-based maps of cumulative insect-related tree mortality across east-side Cascade forests for the entire NWFP area from 1985 to 2007. 2. Statistical (correlative) models relating insect activity, fire risk, and post-fire mortality and recovery dynamics, to set the stage for future hypothesis-driven modeling to improve fire-risk and fuel-load modeling.

Timeline: January-June 2009: Objective 1: Extraction of insect mortality signatures from LandTrendr outputs; Linkage to FHM overflight data.

Ongoing through Oct 2009: Field examination of stratified samples of forest type, insect mortality, and fire dynamics.

October 2009-April 2010: Objective 2: Analysis of interactive effects among predictor variables, development of predictive statistical models, and submission of peer-reviewed reports/papers on all efforts.

Costs:

		Item	Requested FHM EM Funding	Other source funding	Source
YEAR: FY 2009	Administration	Salary (1)	$31,067	$34,500	PNW Research Station, Oregon State University
		Overhead			
		Travel (2)	$6,000		
	Procurements	Contracting			
		Equipment (3)	$2,000		
		Supplies (4)	$400		
	Total		$39,467	$34,500	
YEAR: FY 2010	Administration	Salary (5)	$31,999	$35,535	PNW Research Station, Oregon State University
		Overhead			
		Travel (6)	$1,501		
	Procurements	Contracting			
		Equipment			
		Supplies (7)	$1,500		
	Total		$35,000	$35,535	
1	$18000: 4 months of research assistant time (36000 annual plus OPE);				
	$13067: 2 months postdoc salary (56000 annual salary plus OPE)				
	Other source funding: in kind salary support for Cohen ($15750, 1 month)				
	and Kennedy ($18750, 2 months)				
2	Field work				
3	Computer for field data collection and entry				
4	Misc field supplies				
5	Same as (1) above, with 3% salary raise included				
6	meetings/presentations				
7	publication cost				

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